IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

TITLE:	SIMULATED HUNTING APPARATUS AND METHOD FOR USING SAME
INVENTORS:	John Scott Kennen Jason D. Heald
ATTORNEYS:	Michael P. Mazza Reg. No. 34,092 Michael P. Mazza, LLC 686 Crescent Blvd. Glen Ellyn, IL 60137-4281 Phone: 630-858-5071
ATTORNEY DOCKET NO.:	10021

BACKGROUND OF THE INVENTION

This invention relates to the field of simulated hunting. More specifically, the invention is directed to a simulated hunting device which may be used, for example, to dry-fire a gun or bow equipped with a digital recording device, rangefinding equipment, trajectory calculating software, and image editing software capable of displaying the flight of a bullet or arrow and its impact point on a display screen, allowing hunting without the actual firing of a gun or bow and without harming the target animal.

Various factors have fueled an increasing need for simulated hunting. These factors include increasing population; industrial growth and corresponding shrinkage of huntable land; the presence of large tracts of government-owned, no-hunting lands such as the National Parks; the desire for competitive hunting venues including hunting leagues and/or competitions; and activist groups lobbying against the killing of animals. Accordingly, hunters have experienced an escalating need for simulated hunting experiences and devices, methods and techniques for providing them.

The prior art in the field of displaying projectile impact points discloses methods of calculating and tracking the trajectory of a projectile exiting a firearm from the time it leaves the muzzle to the time at which it would theoretically impact a target. The prior art considers factors such as gravity; distance to the target; the projectile's weight and average speed; and other environmental factors. Many of the methods taught by the prior art incorporate using a range-finding mechanism, such as laser range finders, to determine the distance from the firearm to the target. Trajectory calculating units attached to a firearm are also known, and may be programmed to calculate the effects of the previously mentioned factors on a projectile, such as a bullet. The actual point of impact of a projectile may then be determined

relative to a zero-point reticle calibration. Based on the calculations performed by the trajectory software, a point of impact indicator may then be superimposed on a display unit.

It is also known to provide an integrated display apparatus such as a digital camera attached to a telescopic scope/sight which allows the hunter/user to record the activity seen through the scope before, during, or after firing his weapon. The digital camera may record the activity in its field view from the time it is activated by one of a variety of means, including acoustic detectors, heat change detectors, motion detectors, pressure detectors, electronic detectors, retinal detectors, or manual activation.

Previous methods of simulated projectile targeting do not include coupling the trajectory software with image editing software to provide a device capable of superimposing the entire flight of a projectile, not just point of impact, on the video recorded by a digital camera. No known method of integrating these two disparate software applications has been disclosed in combination with hunting apparatus.

In addition, shooting at up and down hill angles, such as from a tree stand, is common in hunting. However, currently known technology does not take into account the effect degrees of slope have on projectile flight.

The prior art in the field of archery discloses various methods of dampening vibration in the riser caused by the action of shooting the bow. Known dampening methods help stabilize the bow and arrow during firing and aid with bow preservation and arrow accuracy. However, while it is well known in the archery field that dry-firing (e.g., drawing and releasing the bow without firing an actual arrow) can result in damage to the bow and potential injury to the archer, methods enabling safe dry-firing are unknown.

Accordingly, it is an object of the present invention to provide an apparatus for

capturing video and/or audio data of a hunting experience through a data capturing unit which may be equipped with a digital camera that can be manipulated with trajectory calculating software and image editing software to superimpose the flight of a projectile and its impact on a target without the actual firing of the projectile.

It is another object to provide an apparatus capable of aiding a hunter in measuring distance, providing aiming information, and recording flight and impact video data of an actual arrow fired at a target or animal.

It is another object to provide such effects using hunting instruments firing either projectiles or arrows (e.g., guns or bows).

It is still another object to provide a device and method for safely dry-firing a bow.

It is yet another object to provide hunting apparatus able to account for shooting from a slope, to provide accurate uphill and downhill shot trajectory.

It is another object to provide a simulated hunting unit suitable for use in year-round hunting, on no-hunting lands such as National Parks, and in competitive hunting leagues and/or competitions.

DEFINITION OF CLAIM TERMS

The following terms are used in the claims of the patent as filed and are intended to have their broadest meaning consistent with the requirements of law. Where alternative meanings are possible, the broadest meaning is intended. All words used in the claims are intended to be used in the normal, customary usage of grammar and the English language.

"Archery" means a hunting instrument capable of launching an arrow such as a compound, recurve, longbow, crossbow, etc.

"Clinometer" means an electronic sensing device capable of measuring the degree of tilt and/or angle of a hunting apparatus relative to the intended target.

"Dry-firing" means drawing and releasing the bow string without firing an actual arrow.

"Gun" means a hunting instrument capable of firing a bullet such as a rifle, pistol, shotgun, etc.

"Hunting apparatus" means guns or other weapons for shooting projectiles, including archery apparatus such as bows and arrows, etc.

"Momentum suppression rod" means a device facilitating dry-firing of a bow while substantially eliminating the usual safety hazards to the bow or person firing the bow typically encountered when dry-firing occurs.

"Pre-shot adjustment" means use of the hunting apparatus of the present invention to estimate shot parameters by "firing" a pre-shot allowing the hunter to view the flight path of the projectile and adjust the shot parameters prior to making a final shot at an intended target.

"Projectile" means any element capable of being fired by a gun or bow, such as but not limited to bullets, pellets or arrows.

"Site zero impact location" for actual shots means the location of the intended target, i.e., where the crosshairs or sight pins of the hunting instrument (e.g., gun or bow) are aimed and the respective projectile or arrow impacts that spot.

SUMMARY OF THE INVENTION

The objects mentioned above, as well as other objects, are solved by the present invention, which overcomes disadvantages of prior art simulated hunting units and techniques, while providing new advantages not previously obtainable.

In a preferred embodiment of the present invention, a simulated hunting application is provided that utilizes a hunting instrument, such as a gun capable of launching a bullet or a bow capable of launching an arrow. A data capture unit, which may include a video camera, is used to capture imaging data such as video and/or infrared and/or other display data. The data capture unit may also include or be in electrical communication with a range finder, such as a laser range finder, for determining the distance to a target. A display screen is preferably provided for displaying the imaging data, such as an LCD for displaying video data. Trajectory calculating software is employed to calculate the flight path and impact point of the projectile based on a series of variables entered into the program by the user (e.g., wind speed; gun make and model; gun bore length and diameter; arrow shaft length, type, weight, diameter and speed; fletching length, type and quantity; distance to target; parallax; speed of the target, etc.). Image editing software, such as video editing software, is also provided, as is a suitable recording unit for storing the data captured by the data capture unit and data entered into the trajectory calculating software by the user. The image editing software program is capable of displaying portions of a flight path of the projectile, such as generating frame inlays, based on the calculations performed by the trajectory calculating software program, so that the flight path of the projectile may be viewed on the display screen and an impact point on an intended target may also be viewed, such as by interleaving the frame inlays into the video data and displaying the edited frames on the display screen. The display screen may be used to display multi-shot displays corresponding to a plurality of projectiles.

In this manner, the hunting apparatus allows for simulating and superimposing the flight of a projectile and the impact point of that projectile on a target by mock-firing a gun

or bow without damaging the target or harming the animal. The software incorporates the variables entered by the hunter into the trajectory calculation, along with the captured video data, to simulate the true path had an actual projectile been fired. The data capturing unit may be used to display and record video data in digital format, record audio, and use laser range finding technology to measure and record distance to targets. The trajectory calculating software may be used to process the video data captured by the data capturing unit and interface with a video editing software program to display a visual simulation of the path of the projectile.

The video display unit may include a liquid crystal display (LCD) screen that displays the distance, targeting information, the real time image the digital camera is recording, battery information, recording information, etc. If desired, the flight path of the projectile and/or its impact point may also be displayed here, if desired. The video display unit may include a zoom lens function that enhances images of long-range targets. This unit can enhance or replace the bow sight pins commonly used in aiming today.

The image editing and trajectory calculating software programs may also be configured to display: (1) a site zero impact location; (2) images adjacent an intended target and interplay between such images and the projectile (e.g., showing the arrow brushing a branch on its way toward an intended target, being buffeted by wind during flight, sticking in a tree stump next to the intended target that it missed, etc.); (3) information concerning results of the shot, such as whether the shot was a "kill" or "grazing" shot; (4) information concerning the speed of the target at the time of the shot; and (5) information concerning the angle of slope/degree of incline in relation from the hunting unit to the target.

The hunting apparatus may electronically communicate with other electrical

apparatus, such as PDAs (e.g., a Blackberry, a Palm Pilot, etc.), computers, etc. This allows storage of the hunt, as well as downloading of information from the Internet, for example, to augment the hunting application. If desired, the flight path of the projectile and the impact point of the intended target may be viewed on the display screen without first having to download the video data to the electrical apparatus such as a computer.

In the preferred embodiment of the invention, a clinometer may be incorporated to provide angle information of the hunting apparatus. The angle information obtained from the climometer may be used in conjunction with the trajectory software to provide accurate uphill and downhill shot trajectory. An altimeter may also be used to render shooting, particularly bow shooting, more precise in altitude.

In an alternative embodiment of the invention, a simulated hunting apparatus is provided which includes an archery bow having a bow string suitable for launching an arrow, and a momentum suppression rod which allows safe, dry-firing of the bow. The momentum suppression rod attaches to the bow and the string and controls the speed of the string and the limb system's forward motion. The momentum suppression rod may be pressure adjusted to accommodate a wide variety of bow makes, models, lengths, draw-pounds, etc., and may be adapted for different bow types (e.g., compound, crossbow, longbow, recurve, etc.). It may accomplish this speed control by providing back-pressure equivalent to that which an actual arrow would produce in a true firing of the bow. The momentum suppression rod may constitute a mechanically-actuated rod; preferably, however, it is pneumatically-actuated and/or hydraulically-actuated. This hunting apparatus, if desired, may also include and be configured with any and/or all of the devices described above (e.g., data capture unit, display screen, etc.) to provide any and/or all of the simulated hunting functions described above, if

desired.

In one, pneumatically-actuated and/or hydraulically-actuated embodiment, the momentum suppression rod includes a cavity and a piston moveable within the cavity. The piston is capable of providing back-pressure to the bow string upon release of the drawn string commensurate to that which an arrow imparts when actually fired from the bow. In this embodiment, the momentum suppression rod has first and second ends, with the first end connected to the archery bow and the second end connected to the bow string. The second end of the momentum suppression rod may extend toward the bow string in a direction generally normal to the bow string and generally along a centerline of travel of the bow string. The cavity may include a cavity wall and inner and outer chambers separated by a displacement valve. The inner chamber may house the piston, and the outer chamber may include first and second compartments, the first compartment containing a compressed gas, such as nitrogen, and the second compartment containing a liquid, such as a low viscosity oil. The displacement valve may be configured to be adjustable from the outside of the momentum suppression rod to allow varying rates of rod release and back-pressure. The piston, the inner and the outer chambers, and the cavity wall are preferably machined to extremely tight tolerances, such as about .010 +/- .005 inches, to minimize or prevent rod flex or distortion. One or more proximity sensors are located in the piston cavity; preferably, these sensors have a reaction time in the range of about 0.2-0.9 milliseconds. Release of the drawn bow string causes the piston to reenter the inner chamber and forces the liquid back through the displacement valve and into the outer chamber. Similarly, release of the drawn bow string also causes the piston to reenter the inner chamber and recompresses the gas, thereby supplying sufficient back-pressure on the bow string to sufficiently reduce shock and

vibration on the bow necessary to avoid damage to the bow or injury to the user.

In a preferred embodiment, the momentum suppression rod includes a multistage piston capable of extending in multiple portions. Inner extension limiters may be used to engage outer extension limiters at each stage of piston extension, allowing each progressive piston portion of the multistage piston to extend when the previous portion has substantially reached its maximum extension point. The momentum suppression rod may include a charge coupled device camera with a power source and a zoom lens for facilitating the capture of video data; this camera may, if desired, be located in an end cap positioned at one end of the momentum suppression rod.

In yet another alternative embodiment of the present invention, a method is provided allowing a hunter to use a simulated hunting application. The hunter aims a hunting instrument capable of firing a projectile at an intended target. The hunting instrument includes a data capture unit for capturing image data and a range finder for determining distance to target, and a display screen for displaying the image data. A flight path and an impact point for the projectile are calculated based at least in part on variable data entered by the hunter, using trajectory calculating software associated with the hunting instrument. The data captured by the data capture unit and the variable data are captured using a recording unit. The image data may be edited using image editing software to display at least portions of a flight path of the projectile based at least in part on the calculations performed by the trajectory calculating software, so that the flight path of the projectile may be viewed on the display screen and an impact point on or near the intended target may also be viewed. The hunter may also make a pre-shot adjustment by firing an initial, simulated shot, estimating one or more shot parameters based on analysis of the initial, simulated shot and its

corresponding flight path, and adjusting one or more of the shot parameters prior to firing of the next simulated shot at the same intended target.

The hunting unit of the present invention may be used with both actual and simulated hunting applications. Alternatively, the hunting unit may be used to test various conditions and/or devices. For example, the unit may be used to measure distance, provide aiming information, and record flight and impact video data of an actual arrow fired at a target or animal; the rangefinder can help fine-tune distance to target to facilitate shot placement, etc. Preferably, nothing need change in terms of the aspects of scouting, spotting game or other targets, or placing tree stands. Preferably, the fundamentals of firing the hunting instrument remain consistent for both real and simulated hunting.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features which are characteristic of the invention are set forth in the appended claims. The invention itself, however, together with further objects and attendant advantages thereof, will be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view of an archery bow equipped with a mechanically actuated momentum suppression rod for dry-firing the bow, according to one embodiment of the invention;

FIGURE 2 is a rear view of the bow shown in FIGURE 1;

FIGURE 3 is an enlarged, partial side and rear perspective view of the bow shown in FIGURE 1;

FIGURE 4 is an enlarged, perspective view of a preferred embodiment of the data capture unit that is mounted on the bow;

FIGURE 5 is a schematic view illustrating information that may be displayed on the LCD of the data capture unit and may be communicated to an associated computer;

FIGURE 6a is a schematic view illustrating, in one preferred embodiment of software according to the present invention, an example of a computer screen shot a user might encounter at a "Main Page" which may correspond to the logical flow shown in FIGURE 10;

FIGURE 6b is a schematic view similar to FIGURE 6a of a "Speed Page" which may correspond to the logical flow shown in FIGURE 11;

FIGURE 6c is a schematic view of a "Trajectory Page" which may correspond to the logical flow shown in FIGURE 12;

FIGURE 6d is a schematic view of a "Build Arrow" page which may correspond to the logical flow shown in FIGURE 19;

FIGURE 6e is a schematic view of a "Shaft Selector" page which may correspond to the logical flow shown in FIGURE 16;

FIGURE 6f is a schematic view of a "Shot Images" page which may correspond to the logical flow shown in FIGURE 22;

FIGURE 6g is a schematic view of a "Arrow Images" page which may correspond to the logical flow shown in FIGURE 23;

FIGURE 6h is a schematic view of a "Simulator" page which may correspond to the logical flow shown in FIGURES 13-15;

FIGURE 7 is a side schematic view of a preferred embodiment of a momentum suppression rod;

FIGURE 8 is a schematic view of a preferred embodiment of a data capture unit;

FIGURE 9 is a flow diagram illustrating the overall configuration of a preferred

embodiment of the software application according to the present invention;

FIGURE 10 is a flow diagram illustrating the configuration of the "Main Page" of the software application;

FIGURE 11 is a flow diagram illustrating the configuration of the arrow "Speed Page" of the software application;

FIGURE 12 is a flow diagram illustrating the configuration of the arrow "Trajectory Page" of the software application;

FIGURES 13-15 are flow diagrams illustrating the configuration of the "Simulator" shown in FIGURE 10;

FIGURE 16 is a flow diagram illustrating the configuration of the "Shaft Selector" page shown in FIGURE 10;

FIGURE 17 is a flow diagram illustrating the configuration of the "Menu Page" shown in FIGURE 9;

FIGURE 18 is a flow diagram illustrating the configuration of the "Edit Bow" page of FIGURE 10;

FIGURE 19 is a flow diagram illustrating the configuration of the "Edit Arrow" page of FIGURE 10;

FIGURE 20 is a flow diagram illustrating the configuration of the "Configuration Manager" referenced in FIGURE 10;

FIGURE 21 is a flow diagram illustrating the configuration of the "Help Menu" referenced in FIGURE 17;

FIGURE 22 is a flow diagram illustrating the configuration of the "Shot Image Selector" referenced in FIGURE 17;

FIGURE 23 is a flow diagram illustrating the configuration of the "Arrow Image Selector" referenced in FIGURE 17; and

FIGURE 24 is a flow diagram illustrating the configuration of the "Software Updates" utility referenced in FIGURE 21.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Set forth below is a description of what are believed to be the preferred embodiments and/or best examples of the invention claimed. Future and present alternatives and modifications to this preferred embodiment are contemplated. Any alternatives or modifications which make insubstantial changes in function, in purpose, in structure, or in result are intended to be covered by the claims of this patent.

In accordance with a preferred embodiment of this invention, a unit for use in simulated hunting is generally designated with the reference numeral 10, as shown in FIGURES 1-3. A data capturing hardware unit 4, also shown in FIGURE 4, attach to bow 1, preferably by sharing existing mounting holes and/or brackets. Thus, hardware 4 preferably mounts to bow riser 3 using existing mounting holes provided by the bow manufacturer and preferably does not require modifications to the bow. Data capturing hardware 4 is mounted, as shown in FIGURES 1-3, on the side of the arrow rest opposite from the location where the wrist rests, and is preferably attached to the existing mounting holes for the bow sights and/or arrow quiver. Hardware mounting bracket 6 is preferably grooved so that data capture unit 4 may be adjusted up/down and left/right for proper visual alignment for the user, as well as to provide flexibility of placement in conjunction with other accessories. Preferably, the addition of hardware unit 4 to the bow does not require permanent removal of bow components; nor, preferably, does it prevent the use of any bow accessory.

Still referring to FIGURES 1-3, a mechanical version of the momentum suppression rod (MSR) 2 may be affixed at one end to bow riser 3 and also clipped to bow string nock 9 as shown. To provide back pressure to the bow string, bow string nock 9 floats with the string. In a preferred embodiment, MSR 2 contains some of the data capture capabilities of unit 4. The preferred MSR 2, shown in detail in FIGURE 7, is designed to allow a user to safely dry-fire a bow without an arrow. MSR 2 provides the back-pressure normally supplied by an arrow during normal bow firing. MSR 2 can provide some of the data to be transmitted to the hunting unit by housing a wireless charge coupled device (CCD) camera 202 and power source 204 for capturing video data of the hunt, as shown in FIGURE 7. CCD 202 transmits the video data wirelessly to data storage unit 114, as described below. MSR 2 also contains proximity sensors 216 that allow hunting unit 10 to capture data which may be useful for timing various events during the hunt.

Referring to FIGURES 1-3, MSR 2 may constitute mechanical version consisting of a friction rod that preferably includes a runner made of a durable Teflon material that may be closely matched to the rod to produce sufficient drag. Bow string nock or runner 9 may be attached to the string of the bow and drawn to shoot and release in the identical manner as firing the bow with a real arrow. This embodiment is also capable of providing the required back-pressure to prevent damage to the bow or injury to the hunter. However, the mechanical MSR version is not as durable as the hydraulic MSR referenced above and further described below.

Referring now to FIGURE 7, a hydraulically-actuated MSR 2 constituting the preferred version of the MSR is shown. MSR 2 is preferably mounted on the bow riser/arrow rest area 3 of the bow in the centerline of the bow string travel. Mounting MSR 2

containing CCD 202 in the centerline of the bow string travel eliminates the need to calibrate and enter vertical and horizontal offsets in the trajectory and video data software to compensate for the CCD being off-center, because the CCD films from the arrow or projectile's precise launch point. The other end of MSR 2 may clip to bow string 5 via string nock 219. When the user draws bow string 5, inner-multi-stage rod 214 moves first and pulls low viscosity oil 207 (currently envisioned to have a viscosity range of about 40-60 Vi or viscosity index), from reserve tube 210, through displacement valve 206, and into pressure tube 209. Using low viscosity oil 207 permits the user to operate hunting unit 10 over a broad range of temperatures. As inner rod 214 reaches maximum extension, inner rod extension limiters 215 engage the rear of outer rod extension limiters 215, causing outer multi-stage rod 213 to extend through the cavity of pressure tube 209. Preferably, limiters 215 provide magnetic actuation. As the multi-stage rods are being drawn, compressed nitrogen gas 208, currently envisioned to have a preferred compressible range of about 20-30 psi, in reserve tube 210 expands to fill the void created in reserve tube 210 by the removal of the low viscosity oil. The condensed nitrogen gas also assists the user in drawing bow string 5. When outer rod 213 reaches maximum extension, extension limiters 215 engage proximity sensors 216. Proximity sensors 216 transmit signals to data capturing unit 4, feeding the draw/release data to the trajectory calculating and video editing software for use as described below.

When the user releases bow string 5, inner multi-stage rod 214 moves first. Multi-stage rod piston 212 forces the low viscosity oil out of pressure tube 209, through adjustable displacement valve 206 and into reserve tube 210. The compressed nitrogen gas 208 that was permitted to expand in reserve tube 210 during the draw is compressed back to its

original pounds per square inch (PSI) level. Spring loaded bump stop 211 may be incorporated in pressure tube 209 and may be engaged by multi-stage rod 212 if the desired maximum compression rate is exceeded.

MSR 2 preferably is compact in shape due to its multi-stage design. Alternatively, though less compact, MSR 2 could be provided with single-stage rods, which would require three times the overall length of the multi-stage rod for proper operation. Piston 212, inner and outer rods 213, 214, and cylinder wall supports 217 are preferably machined to extremely tight tolerances to minimize rod flex or distortion. Supports 217 limit extension of multi-stage rod piston 212. Displacement valve 206 is preferably adjustable from the outside of the MSR using displacement valve adjuster 205 to allow the user to fine-tune the MSR release and back-pressure rate. This feature permits the user to adjust the MSR across various bow draw lengths, weights, release speeds and types. In this preferred embodiment, MSR 2 houses CCD 202 and proximity sensors 216, which preferably employ wireless technology and reduce the mounting requirements (e.g., weight and convenience) of data capturing unit 4 on the bow. Preferably, CCD 202 in MSR end cap 201 has a zoom lens 203.

Alternative configurations of simulated hunting unit 10 shown in FIGURES 1-3 are possible. For example, in one alternative embodiment, the CCD and proximity sensors may not be housed in MSR 2 but, instead may be mounted separately on the bow 1 within the data capture unit 4, for example. This configuration requires data capture unit 4 to be aligned and calibrated for vertical and horizontal offset in relation to the arrow set. The offset may be determined by measuring the vertical and horizontal offset of the crosshairs centerline in relation to the centerline of the arrow. These calculations allow for proper placement of the impact spot on the video frames (shown in FIGURE 5, for example) during the pixel-division

trajectory calculations process, referenced below. In this alternative embodiment, the offset dimensions may be entered into a software program in the Bow/Unit Information fields of FIGURE 6a in the trajectory calculating software program, as further described below.

To facilitate use of the invention, the user may determine the "site zero impact location" for actual shots, which is defined by an arrow impacting the target in the exact spot that the crosshairs or sight pins in hunting unit 10 were aimed. The trajectory calculating software can then accurately estimate the lift and drop associated with the arrow's flight path at given distances for editing the impact spot during simulation mode. To do so, the user may first enter certain variables into the trajectory calculating software program, such as arrow shaft length, type, weight, diameter and speed; fletching length, type and quantity; distance to target; and parallax.

FIGURE 4 shows data capture unit 4 of the invention, which in one embodiment may include a laser range finder as well as the video recording device. In the preferred embodiment, a laser range finder and recording device may be attached to the bow as shown in FIGURES 1-3. Referring now to FIGURE 8, an alternative embodiment of data capture unit 4 is shown. In this embodiment, MSR 2 does not house the CCD camera and proximity sensors. Instead, these components attach to the bow as part of data capture unit 4, separate from MSR 2. Here, the laser range finder components may include a laser light transmitter 101, which sends a pulse of laser light to the target (not shown), and a receiver 102 that receives the returned laser light. Receiver 102 sends the signals from the returned laser light to processing board 103, which uses the signals to calculate the distance to target based on the laser light's time of flight. The user may activate the laser range finder unit by depressing remote switch 104, which may send a signal to hunting unit 10 via wire 105.

The preferred laser range finder is a Bushnell Laser Rangefinder – Model Yardage Pro Sport. This device is preferred because of its accuracy to +/- 1 yard; its ability to signal on deer from 5 to 200 yards (the typical bow shot is 10 to 40 yards); its extremely light weight and compact design, which is an important feature when attaching it to the bow; its Integrated Perma Focus monocular optical system 109, providing 4x magnification; and its Integrated LCD display 106 for ranging information, which is easy to capture and display through a camera. Commercially available battery 107 may be used power the range finder.

Still referring to FIGURE 8, the operation of the preferred embodiment of data capture unit 4 will now be explained. CCD 202 captures light 108 as it enters Perma Focus monocular optical system 109 and LCD 106. Processing board 112 converts light 108 into electrical signals captured by monocular optical system 109. Recording device 111 converts the electrical signals from processing board 112 into an image and displays the image on LCD 113 in camera 111. Camera 111 has storage device 114 which stores images for editing and play back. Using external switch 115, the user can turn the camera 111 on and off. External switch 116 controls the recording mode of camera 111. LCD 113 may be used to display, for example, aiming crosshairs and/or sight pins, distance to target obtained by the laser range finder, a target acquisition indicator, unit battery condition, and the recording field of view. Storage device 114, such as a scan disc card, may be used to store the distance and aiming data displayed on LCD 113 along with the video images captured by camera 111. This information may be automatically updated and used by the trajectory calculating software and video editing software programs to simulate the flight path and calculate a point of impact for the arrow. The integrated software uses the data captured by camera 111 and the laser range finder to add frame inlays of an arrow in flight and at impact to the video data.

The available recording modes provide both video and audio or still photography of the hunt.

It may now be appreciated that with use of the present invention, arrow flight and/or impact may be superimposed onto visible backdrop or background images. For example, if the projectile or arrow misses its intended target animal, it may be seen to impact an adjacent tree trunk. Further, during its flight path, the arrow may be seen to brush tree leaves, as another example.

The preferred model for camera 111 is the Panasonic e-wear camera – Model SV-AV1OU. This model is preferred because of its compact nature and light weight, since overall size and weight is a concern when attaching the device to the bow. The SV-AV1OU Scan Disk multi-media cards are lightweight (1.5g, 32mm x 24mm, and 2.1mm thick), have a high transfer rate for fast copy/download, and have a high storage capacity (current cards can store 5 hours of video). The Scan Disk cards also have a non-volatile solid-state with no moving parts, which maximizes battery power. In addition, no data is lost when the power is turned off. The Scan Disk cards consume little battery power, which maximizes battery life. They have an operating shock rating of 2,000 Gs, equivalent to a 10-foot drop to a solid surface, making them ideal for use in a hunting tree stand. Finally, the Scan Disk cards have high vibration resistance and are unfazed by drastic weather conditions ranging from -13^0 F to 185^0 F. Additional features of the Model SV-AV1OU include an integrated microphone, a high resolution 2" LCD (200,000 pixels), a wide angle pinhole CCD, and a rechargeable lithium-ion battery system.

In more preferred embodiments, the LCD screen changes from a flip-out version to a model that can slide right or left from the rear of the bow to allow for more flexible positioning. This embodiment also consolidates the separate LCD screens for the laser range

finder and CCD, so that only one LCD screen is necessary. Preferably, the laser range finder sends the distance to target data to be displayed on the single LCD screen rather than using a separate LCD monitor for the laser range finder. This embodiment eliminates the requirement on the CCD camera of having to shoot through the range finder optic to collect distance to target data. It also permits the ideal placement of the CCD camera in momentum suppression rod/MSR 2.

As referenced above, proximity sensors 216 may be used to control the start/stop recording function to determine the release time of the arrow. These sensors may be integrated into MSR 2. In the preferred embodiment, the proximity sensors transmit information to the trajectory and video editing software wirelessly. However, in an alternative embodiment, the proximity sensors 216 may be connected to processing board 112 via wire 120 to provide time of release information to the trajectory calculating and video editing software in processing board 112, as shown in FIGURE 8. In yet another embodiment, the user can activate the start/stop recording function on camera 111 with manual switch 119. Wire 121 connects manual switch 119 to processing board 112. Rechargeable battery 122 powers the recording unit. In a more preferred embodiment, rechargeable batteries 107 and 122 are replaced by a single rechargeable battery unit capable of powering both the laser range finding and the recorder.

The preferred proximity sensors 216 for the invention are Cherry Corp. Proximity Sensors, sensor model MP201701 and actuator model AS201701. These Cherry proximity sensors are preferred because they operate over a weather range from -40^{0}F to 221^{0}F. Their reaction/operating time of 0.6 msec may be important because the timing of the arrow's flight from draw and release to the start/stop time of the video affects the trajectory

calculation and video editing process. 0.2-0.9 milliseconds (msec) is a particularly preferred range for the reaction time of the proximity sensors. These Cherry proximity sensors also have a high resistance to dirt, moisture, etc. which makes them ideal for typical hunting environments. Finally, the Cherry Corp proximity sensors are miniature and lightweight which makes them well-suited for mounting on the bow.

When using hunting unit 10 of this invention, multiple methods of training are possible. Simulation shooting allows the user to learn the simulation characteristics of the unit and how variables such as arrow weight and fletching type impact the shot. The user can also perform real world shooting with the unit. Hunting unit 10 enhances an actual shooting experience by recording actual arrow flights and impacts for later analysis. The unit also allows for slow-motion control during video playback of a hunt scene to view arrow flight characteristics (e.g. arrow shaft flex and oscillation during launch/flight, rate of arrow spin from fletching placement, etc.). Finally, the unit helps a hunter fine-tune his or her distance assimilation. Generally, hunters rely on sighting pins to determine distance and aim. Sighting pins require the hunter to guess at target distances and, therefore, aiming characteristics as well. With the simulation unit of the present invention, a hunter is able to determine the actual distance to a target with the laser range finder, allowing him/her to make better use of the sighting pins. Also, by using the laser range finder during practice, the user can become more adept at determining distances by assimilating what the eye sees in relation to the yardage displayed by the unit.

In the preferred embodiment of the invention, bow sighting pins may be incorporated in data capture unit 4 for display in the LCD camera. This allows the user to aim with the unit 4/LCD combination in the same manner as mechanical pins by employing a utility in the

unit that adjusts the pins up and down to compensate for arrow drop. This embodiment of the unit also includes crosshairs for aiming the range finder to determine the distance to a target.

The first step in using this invention for simulated hunting is to open the LCD screen in data capturing unit 4 for viewing. The user may then power on the unit and select the proper mode (video, still photo, etc.). Preferably, the LCD is programmed to display the recording mode information, date and time, target acquisition mode, distance to target, distance units (e.g., yards or meters), aiming crosshairs, and battery conditions for the digital camera and the laser range finder. The user may then position the LCD for viewing to accommodate a comfortable position while aiming and recording.

In firing, the user grips the bow, draws the string, and takes aim in the same manner as when actually shooting an arrow. The user may establish the distance to a target by activating the laser range finder, and may then aim at the target with aiming crosshairs and trigger the laser range finder a second time to determine the distance to target. Data capture unit 4 captures the data from the laser range finder and records the data for use by the trajectory calculating software after firing. With the discussed embodiment, it is desirable to trigger the laser range finder again just prior to releasing the shot to ensure that accurate distance to target data is recorded and used by the trajectory calculating software. If the distance to target is greater or less than 1 yard from the previous reading, the trajectory calculations may be materially incorrect.

Preferably, the user is permitted to manually activate data capturing unit 4 at any time. Thus, a hunter may choose to record only the shot sequence and/or an animal's approach before and departure after the shot sequence. Alternatively, the hunter may choose

to capture the entire experience for reference, cataloging, or later recounting to friends.

When in shot simulation mode, the proximity sensors may be activated by the bow-string movement and/or the MSR, to activate the camera's recording start/stop functions. The unit may determine when an arrow is released based on MSR and/or string movement. This information may then be used in calculating the shot trajectory and generating frame inlays by the video editing software. The software preferably marks the video frames during this sequence so that the video editing software recognizes the draw/release frames of the shot for auto-editing the video. As described above, drawing the string activates a proximity sensor which in turn produces a start time that is fed to the digital camera so that it begins recording.

When the shot is released, a proximity sensor triggers a stop time that may then be fed to the digital camera, to stop its recording. With those time stamps, unit 4 determines the time of flight to the target based on the distance recorded from the laser range finder and the speed of the arrow, which is preconfigured into the software. In a more preferred embodiment, the MSR captures speed data and eliminates the need to manually determine the speed of the bow as illustrated in the software program. The software determines the speed of the arrow by measuring the speed at which the MSR goes from extension to rest. This allows data capture unit 4 to determine which frame in the video will be used to mark the shot.

When the frames to be edited have been determined, a pixel-splitting algorithm may be utilized to determine the pixel cross-section on which to place the impact spot. A pixel takes up a predetermined amount of space on the display screen for the data capture unit. An appropriate formula may be derived to indicate the change in pixel size given corresponding

target distance changes. Data capturing unit 4 and storage device 114 capture and record this information for video editing. In one embodiment of the invention, storage device 114 may be removed from the unit and the video uploaded to the video software for editing. In the preferred embodiment of the invention, a USB port downloads data captured by the unit to a personal computer/PC (and its video editing software) and uploads configuration data from the PC to the unit. This allows the user to view the shot on the LCD monitor mounted on the bow. Preferably, the video editing software is QuickTime software available from Apple Computer, Inc.

In this preferred embodiment, data files are created during the shot and saved to the storage unit to automate the trajectory calculating and video editing steps. Data capture unit 4 may then use these data files to time bow string release and stop to calculate arrow speed, arrow release, and other variables necessary to calculate the trajectory of the arrow. This configuration also allows the unit to upload the variable data from the PC software to calculate the flight path and impact point of the arrow and display each on the LCD for the user. This configuration provides visual confirmation of the outcome immediately after the shot without having to proceed with the steps of downloading the video data from the unit to the PC for calculating the trajectory. This embodiment also allows multi-shot displays to create a cluster for the user during the exercise. The shot clusters can be saved to the storage device and loaded on the PC for further analysis. This provides the user with the ability to study the effects of changing the variables and how they influence overall performance. It also allows the user to determine how other forces not compensated for by the trajectory calculating software (such as hold and release times, bow vibration, release movement, etc.) influence the result.

A preferred embodiment of the invention also provides remote auto updating of the trajectory calculating and video editing software from a customer's computer, as shown in FIGURE 21. This enables the user to download software enhancements or changes and new manufacturer data directly from the Internet.

As described above, simulated hunting unit 10 preferably includes trajectory calculating software interfaced with video editing software. The software applications are preferably interfaced between the data capturing unit and a PC. In the preferred embodiment, a USB port incorporated in the hunting unit allows for downloading captured data files to the PC and uploading configuration data from the PC to the unit. The PC software preferably includes an arrow speed estimation program that uses data files recorded by the data capturing components. The PC software also preferably incorporates an arrow trajectory calculator which uses trajectory algorithms to calculate the trajectory of the simulated arrow. The arrow speed application may use data captured by the unit such as poundage draw of the bow, arrow weight, fletching type, and other variables to determine arrow speed. Data which may be used by the trajectory software includes distance to target, arrow weight, arrow speed, fletching type, and other variables. Information about the trajectory calculator may be found in *Physical Laws of Archery*, 1988 (4th ed. 1991) by T.L. Liston. Additional information on trajectory algorithms is available at http://dspace.dial.pipex.com/town/terrace/qq53/.

The trajectory calculator interfaces with video editing software such as QuickTime for Java – Developer Edition, available from Apple Computers, Inc. Using the calculations performed by the trajectory software and the video data recorded by the CCD, the software may be used to determine and display the arrow's flight path and point of impact. The video

editing software supplies frame inlays of projectiles (e.g., arrows) to display the flight path and point of impact on the target. In a preferred embodiment, the user can view this information, such as on an LCD screen associated with the hunting apparatus, immediately after the simulated hunt.

A further software application which may be used with the present invention is a target size estimation program allowing the user to estimate the size and weight of the target animal. The program is based on the pixel division calculation functionality used in the trajectory/impact marking program. Because area mass by pixel is known throughout various ranges, the program is able to determine the length and width of objects within the frame.

Industry algorithms exist to calculate animal weight based on length, width, and girth dimensions of an animal. Thus, using the software of the present invention, a user can provide the size of a deer or the size of its rack, for example, and the software will provide its dimensions, through use of the pixel splitting algorithm referenced immediately above, using readily commercially available information. For example, Pope & Young and Boone & Crocket use antler dimension (spread, tine length, etc.) to score an animal for record purposes.

FIGURES 9-24 outline a preferred embodiment of the software applications' operation for using in simulated bow firing and tracking. FIGURE 9 shows the overall configuration of the software. FIGURE 10 shows the configuration of the "Main Page" application in FIGURE 9. Variables affecting the final product include changing the data configuration and selecting the type of shaft, bow, or arrow. FIGURE 10 also provides the option of initiating the simulation.

By modifying existing software illustrating animal anatomy, the software of the present invention may be configured to provide information to the hunter concerning the shot result. For example, the software may analyze the shot location and indicate whether the shot was a "kill" or "grazing" shot. In addition, the software of the present invention may also be modified to account for and provide other information, such the speed of the animal at the time of the shot.

Hunting apparatus 10 may be provided with night vision capability, if desired, such as by incorporating a NIR CCD-65L available from ITT Industries. The CCD may be mounted in the MSR, as described for the hydraulic version. The CCD-65L provides a non-intensified NIR low-light-level imaging technology, and is believed to be ideally suited for use in hunting applications both in day and night conditions. With a faceplate sensitivity of 0.00003 foot-candles (twilight = 1 foot-candle) and an advanced automatic gain control algorithm, the camera delivers useable imagery under wide dynamic lighting conditions. Benefits of the CCD-65L includes exceptional low-light performance; high sensitivity in NIR; auto-iris drive signal; "C"-mount lens interface; low power consumption; and rugged construction.

In the preferred embodiment of the invention, a commercially available clinometer, such as Accustar Single Axis clinometer, may be incorporated to provide angle information of the hunting apparatus. The angle information obtained from the climometer may be used in conjunction with the trajectory software to provide accurate uphill and downhill shot trajectory. Shooting at up and down hill angles, such as from a tree stand, is common in hunting. Currently known technology does not take into account the effect degrees of slope have on projectile flight. Operating specifications for the Accustar clinometer include: tilt

range (degrees): -60.00 to 60.00; number axis: 1.0; accuracy (degrees): 1.0; operating temperature: –22.0 to 149F; weight: 2.oz; diameter: 2 inches; height: 1.2 inches. Commercially available altimeters may also be used to render shooting, particularly bow shooting, even more precise when shooting in altitude.

To further describe a preferred embodiment of the invention, FIGURES 6a-6h illustrate exemplary screen shots from a display screen on an associated computer which a user/hunter might encounter during use of the present invention. FIGURE 6a, for example, illustrates one example of a "Main Page" which may correspond to the logical flow shown in FIGURE 10, enabling the user to modify existing configurations, create new configurations or change to existing configurations. From this page, the user may also edit bow information, arrow information, shaft selection, and the simulator. FIGURE 6b illustrates a "Speed Page" which may correspond to the logical flow shown in FIGURE 11, enabling the user to calculate the initial speed of an arrow. For example, the user may be required to enter a certain number of marks (e.g., between 2 and 5), to determine feet/sec speed of the projectile exiting the hunting apparatus. FIGURE 6c illustrates a "Trajectory Page" which may correspond to the logical flow shown in FIGURE 12, enabling the user to display the flight a projectile such as an arrow may take in order to hit the desired sight line at a given yardage. FIGURE 6d illustrates a "Build Arrow" page which may correspond to the logical flow shown in FIGURE 19, enabling a user to populate the data needed by the trajectory software, using a preconfigured database of manufacturer arrow data, by having the user enter information concerning the (e.g.) arrow(s) being used. FIGURE 6e is a schematic view of a "Shaft Selector" page which may correspond to the logical flow shown in FIGURE 16, enabling the user to select an arrow that best suited for his/her bow configuration. FIGURE

6f is a schematic view of a "Shot Images" page which may correspond to the logical flow shown in FIGURE 22, enabling the user to change the image that will be displayed on the simulator at the time of impact. FIGURE 6g is a schematic view of an "Arrow Images" page which may correspond to the logical flow shown in FIGURE 23, enabling the user to select the image that will be used to display the flight of the arrow while using the simulator. FIGURE 6h is a schematic view of a "Simulator" page which may correspond to the logical flow shown in FIGURES 13-15, enabling the user to watch the hunt along with displaying the selected arrow image following the flight of the arrow and the selected shot image at the point of impact. It will be understood that appropriate changes may be made to the software described here to accommodate the use of other projectiles such as bullets, as will be understood by those of ordinary skill in the art.

The present invention also permits a hunter to "pre-fire" a shot and view its flight path and impact point on the display screen, and then make a "pre-shot adjustment" by modifying shot parameters. Known simulated hunting devices, which do not allow display of the projectile's flight path, do not permit such a pre-shot adjustment.

Of course, it should be understood that various changes and modifications to the preferred embodiments described herein will be apparent to those skilled in the art. For example, the trajectory calculating software and video editing software described above may be specially adapted for use with simulated hunting utilizing guns firing projectiles. As another example, the MSR 2 and data capture unit 4 may be combined into a single unit possessing, for example, an integrated data chip in which the unit provides the combined MSR and data capture unit functionalities. As yet another example, the MSR described above may be pneumatic/air-actuated and/or gas-driven. As still another example, the

projectile or arrow flight path and target point may be displayed, alternatively, on an LCD associated with the data capture unit and/or on a display screen associated with computers, PDAs or other electronic equipment communicating with the hunting apparatus. It will also be understood that the video editing software and trajectory calculating software may be combined into a single program.

Other changes and modifications constituting insubstantial differences from the present invention, such as those expressed here or others left unexpressed but apparent to those of ordinary skill in the art, can be made without departing from the spirit and scope of the present invention and without diminishing its attendant advantages. It is, therefore, intended that such changes and modifications be covered by the following claims.